

Final Errata Memo - TSV

ECE 492 - Spring 2015

Latest Revision: 15 May 2015

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Abstract

This document will fully describe the errata proposed for addressal by the LFEV 2015 TSV team. It will also include an analysis of which errata were corrected, which were left unresolved, and any new errata resulting after the Spring 2015 semester. This information is made available for any future teams who wish to develop and attempt redesign of the TSV system.

Key

RESOLVED: The errata/issue has been addressed and completed as of Spring 2015.

ADDRESSED: The errata/issue has been addressed as of Spring 2015, but may need further adjustments to be considered complete.

INCOMPLETE: The errata/issue has not yet been addressed as of Spring 2015; extensive adjustments are necessary to be considered complete.

DESCOPED: This errata was considered 'descoped' for LFEV 2015.

Proposed Errata

- The AMS cell manager and Pack Man “BOB” boards have several layout errata noted by the 2014 team. These errata, and any other issues shall be corrected in newly produced boards.

RESOLVED: All physical layout errata existing from LFEV 2014’s system has been addressed and corrected by the LFEV 2015 team. All layout changes have been implemented in the current PCB and Gerber files, which can be accessed on the LFEV 2015 website, under the tab ‘TSV’. A link to the website has been included in the References of this report.

- The AMS cell manager firmware has a documented bug where incorrect data is returned on some reads. This shall be corrected in newly produced boards.

RESOLVED: The AMS firmware bug existing from LFEV 2014’s system has been eradicated from the LFEV 2015 design. This design replaced the LFEV 2014 PacMan computer with a microcontroller hosted on the Breakout Board, and will host a completely new library of software for functionality. Since the bug existed within the 2014 software code, this is no longer a factor in our system.

- In the 2014 pack design, there is no provision for holding down cell manager boards. A retaining bar or other device shall be added to the pack so that the cell manager boards don’t work loose.

ADDRESSED: As of Spring 2015, the supporting Mechanical Engineering team has developed a foam retaining plate to hold the AMS boards in place within the cell. Attached to the removable pack top, the plate will tightly hold the boards down when the pack is fully constructed. Any inventor files depicting this can be found within the MECHE Independent Study 2015 documentation. However, due to errors in spacing during fabrication, the pack top and foam retainer do not currently fit as expected with the AMS boards and their heatsinks. As such, small modifications in either the heatsink size or the pack top must be adjusted in future designs.

- After removing a cell terminal access maintenance cover or simple assembly, it shall be possible to access all individual cell terminals for the purpose of making direct handheld DMM measurements of cell voltage at cell terminals or junction bars without requiring extensive disassembly of the pack or rendering the pack non-functional. This requirement is intended for maintenance only and shall not conflict with the EV rules that prohibit probe contact with TSV high voltage during normal operation when the maintenance cover shall be firmly fastened shut.

RESOLVED: As of Spring 2015, the supporting Mechanical Engineering team has redesigned the pack to be constructed of easily removeable aluminum plates, including a top piece that allows for easy access to the AMS boards inside. Total disassembly is no longer required to access certain parts of the pack, while still abiding by FEV rules for safety. Any

inventor files documenting this can be found under the MECHE Independent Study 2015 documentation.

- The TSV Accumulator pack mechanical design and packaging shall be reviewed and improved so as to be fully compliant with all Formula EV rules, including shock, vibration, temperature, and humidity (including rain).

ADDRESSED: Due to the incompleteness of the accumulator pack, it could be not fully tested to be compliant with all FEV rules, as of Spring 2015. However, all mechanical and electrical parts used in the potential construction of the TSV system are compliant. All purchased parts (electrical and mechanical) can be found listed under the System Bill of Materials, found under the 'TSV' tab on the LFEV 2015 project website. This errata should be addressed again after successful fabrication of the pack to be considered complete.

- Pack current measurement shall be corrected for the temperature rise in the aluminum resistor bar. This causes significant error in the current measurement.

INCOMPLETE

- Offset in the current measurement shall be corrected. The current measurement must read correctly when the actual pack terminal current is zero. SOC estimates must consider current measurement offset correction.

INCOMPLETE

- The ambient temperature in the pack shall be measured.

ADDRESSED: LFEV 2015 was able to implement the physical hardware of ambient temperature sensing by including temperature sensors within the pack. However, no software yet exists to poll and utilize or monitor the temperature sensor readings. As such, this software should be implemented for this errata to be considered complete.

- Sensors shall be provided in the pack such that VSCADA can determine if there is a failure in the main fuse or either AIR.

DESCOPED

- Reset buttons, per GPR005, are required.

ADDRESSED: LFEV 2015 was able to design, implement, and fabricate the hardware needed to include a full reset for the accumulator pack. This includes an outer remote reset button on the outside of the pack which, when activated, resets the BoB and subsequently, each of the AMS boards. However, due to constraints, LFEV 2015 was unable to fully test and approve the working of this system. As such, future teams should fully test the system reset to have this errata considered complete.

- The State of Charge (SOC) estimate displayed by the 2014 PacMan firmware is invalid. A correct SOC estimate is required.

INCOMPLETE

- Rebooting the system should not invalidate or significantly degrade the accuracy of the SOC estimate.

INCOMPLETE

- A fully discharged (dead) pack shall be chargeable with the plug and forget system without disassembly or special actions.

INCOMPLETE

- In the 2014 design, the available space on the LCD display is poorly used and the information displayed is not adequate. Specifically, display space should not be wasted on permanent display of the programmer's name. Individual cell voltages, pack voltage, all temperatures, bypass states, pack state, last error, last warning, and last informational message should be viewable. The firmware version should be displayed on boot. Some form of interactivity with the display (e.g. keypad) is desirable if this enhances use of screen space and adheres to strict HV/LV segregation rules.

ADDRESSED: LFEV 2015 was able to replace the LFEV 2014 LCD design with a smaller, more space efficient LCD display in the pack. However, the software developed to control and monitor this display is, as of Spring 2015, incomplete and untested. As such, any future use should review the provided code library to consider this errata complete.

- Competition rules require an independent 30V indicator for safety.

ADDRESSED: LFEV 2015 was able to implement the hardware and circuitry for a 20V LED indicator that is on the outer of each pack in the TSV system. However, this implementation was unable to be tested and approved as of Spring 2015, so full testing should be done to consider this errata as complete.

- Power management is poor for the AMS. The PacMan computer quickly discharges an idle pack. Improved power management software and hardware shall allow the pack to safely sit idle or be operated without fear of over-discharge and damage.

RESOLVED: LFEV 2015 was able to implement the replacement of LFEV 2014 PacMan computer with a more efficient design of the AT90CAN32 microcontroller. This severely reduced the power consumption of the pack, and doubled the life of the idling pack from around 30 days to approximately 66 days.

- A low-battery warning shall provide visible indication that the pack is in need of charging. This shall be above and beyond the required display of SOC.

INCOMPLETE

- The Anderson port used for charging, or some other suitable port, should be available for powering low current (<20A) devices by simply plugging them in.

INCOMPLETE

- The PacMan should perform detailed logging.

DESCOPE

- Charge Algorithm – Because the cell voltage varies as the pack's current and temperature changes, it is not sufficient to base SOC estimates and charge termination conditions exclusively on crude cell voltage. The existing charge algorithm has not been proved by QA testing. An improved charging algorithm based on a more comprehensive set of cell measurements shall be developed. Preferably the algorithm should use impedance spectroscopy or time-domain dynamics. Similarly, discharge limits shall consider all relevant cell measurements, not only crude cell voltage.

INCOMPLETE

- Measurand Calibration and Accuracy – The AMS design must be analyzed by a Calibration and Error Analysis document (R011) that estimates the uncertainties associated with all AMS measurands, especially SOC.

INCOMPLETE

- The delivery of a fully integrated, fully updated, fully tested 4-pack TSV accumulator is required in 2015.

DESCOPE TO ONE PACK

- A watchdog timeout must exit the charging state to prevent overcharging if an external charging source is connected. Many other possible failures can allow overcharging. This is a serious safety concern that must be resolved.

INCOMPLETE: Note: There also exists a continued errata from LFEV 2014 wherein the current watchdog hardware repeatedly resets, as noticed by the continual audible clicking of the system when powered. This is documented under the LFEV 2014 errata memo, and should also be addressed for this errata to be considered complete.

- A wired interface shall be provided that interfaces the pack AMS to VSCADA. This interface shall adhere to the strict HV/LV segregation rules and shall support all required operational modes.

ADDRESSED: As of Spring 2015, the LFEV 2015 team was able to implement the interconnects and hardware to enable CAN communication with the VSCADA system. However, the software for this process is incomplete, and must be developed and tested for this errata to be considered complete.

- The PacMan should perform detailed logging.

RESOLVED: Since the LFEV 2015 replaced the LFEV 2014 PacMan computer with a microcontroller, all software utilized by the 2014 system was discarded. As such, the unfit configuration file is no longer a part of the current TSV system.